LANDSAT CLASSIFICATION:
EVALUATION OF IMAGE ANALYSIS
METHODOLOGIES FOR WILDLIFE HABITAT
MANAGEMENT AND RESEARCH PLANNING

Working Plan

INTEGRATED WILDLIFE INTENSIVE FORESTRY RESEARCH

Province of British Columbia

A cooperative project between the Ministries of Environment and Forests

LANDSAT CLASSIFICATION: EVALUATION OF IMAGE ANALYSIS METHODOLOGIES FOR WILDLIFE HABITAT MANAGEMENT AND RESEARCH PLANNING

Working Plan

K.L. Sadoway

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Victoria, B.C.
V8W 3E7

or

Fish and Wildlife Branch
Ministry of Environment
Parliament Buildings
Victoria, B.C.
V8V 2X5

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Summary

This study is designed to evaluate three Landsat image classification methodologies. The three Landsat image formats used include: (1) paper print; (2) positive transparencies; and (3) DICS computer tape. An evaluation will be made in terms of cost, accuracy, precision, and the utility of the classification system developed.

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1 PROBLEM REFERENCE

As intensive forestry management increases on Vancouver Island, knowledge concerning wildlife/intensive forestry interactions becomes critical. Information on the current habitat types available would provide a vehicle for research site selection and subsequent research result extrapolation. Unfortunately an accessible, current habitat map is not available. A methodology is needed to provide this information.

Landsat image analysis is able to provide a current, cover type classification map (Sadoway 1980). The uses of Landsat image analysis, the kinds of classification systems developed, their merits and shortcomings, and the inherent problems in this type of analysis were presented in a problem analysis (Sadoway 1980). This project forms the first step in the recommended studies to develop a wildlife habitat classification system for Vancouver Island.

2 OBJECTIVE

To evaluate three Landsat image classification methodologies: (1) paper print analysis; (2) positive transparency analysis; (3) digital computer tape (DICS) analysis.

To evaluate the classification system developed.

3 METHODS

3.1 Selection of Material

3.1.1 Landsat Images

Landsat images will be selected using the following criteria:

(1) DATE - most recent image available,
- late summer-fall scene preferred;

(2) SNOW COVER - minimum amount;

(3) CLOUD COVER - minimum amount; and

(4) IMAGE QUALITY - band quality.

Although when previewing Landsat images a whole Landsat scene is represented, the above criteria will be applied only to the area of concern (i.e. 2 X 2 NTS quadrant matrix).

Landsat images will be previewed and selected using the ISISFICHE (microfiche) available at the Terrestrial Studies Branch, Ministry of Environment. A computer printout record of all available images, the percent cloud cover, and image quality will also be used in the selection process.

The same image (i.e. date/area) will be used for the three Landsat image analyses.

3.1.2 Aerial Photographs

Aerial photographs will be used for ground truthing and classification designation. Aerial photographs will be selected using the following criteria:

(1) DATE - of the available photos, the date closest to that of the Landsat image.

(2) COLOUR - colour photos will be used whenever possible, black-and-white when colour is not.

(3) SCALE - 1:20 000 or 1:40 000 preferred.

3.2 Acquisition of Material

3.2.1 Landsat Images

Upon selection of the image(s), imagery data will be ordered in three formats. Format specifications and a sample of the order form are included in the Appendix (sec. 11.1.1 and 11.1.2, respectively).

3.2.2 Aerial Photographs

Once the date of the selected image(s) is known, information on aerial photograph availability, scale, and colour from Inventory Branch, Ministry of Forests will be used to acquire the photographs. Photographs will be borrowed from Vancouver Region (MOF) when possible. Any prints to be made will be supplied by Surveys and Mapping Branch, Ministry of Environment, Victoria.

If three sets of aerial photographs are available, a set will be sent to each analyst along with the appropriate Landsat image format. If only one complete set is available, then the analyses will be carried out consecutively rather than concurrently.

3.3 Design and Layout

3.3.1 Study Areas

Two 2 X 2 NTS quadrant blocks are proposed (see Figure 1):

1. Sayward Forest[a]
   area of NTS 92K 3, 4, 5, 6
2. Southcentral Vancouver Island
   area of NTS 92F 1, 2 and 92C 15, 16

The Sayward Forest area was chosen for two reasons: (1) this area is currently the focus of a Roosevelt elk study (EP 912), a black-tailed deer study (EP 923), and a MOF Vancouver Region ecosystem study; and (2) it has a forest mosaic of currently logged, recently logged, 30 year old second growth, and mature forest.

Although the study area delineated on southcentral Vancouver Island does not currently have as high a wildlife priority, it does provide a forest type mosaic similar to the Sayward Forest area but contains a larger area of second growth forest of approximately 90 years of age.

A 2 X 2 quadrant matrix is used because this is the area available on one geometrically corrected computer tape (DICS).

Two study options are presented in this working plan. The first option involves the analysis (method and classification development evaluation) of the Sayward Forest study area only. Option two involves the analysis of both areas designated above: the Sayward Forest area and the Southcentral Vancouver Island area.

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[a]The name 'Sayward Forest' for this study area is descriptive and is used for convenience only. The study area does not include the whole Sayward Provincial Forest.

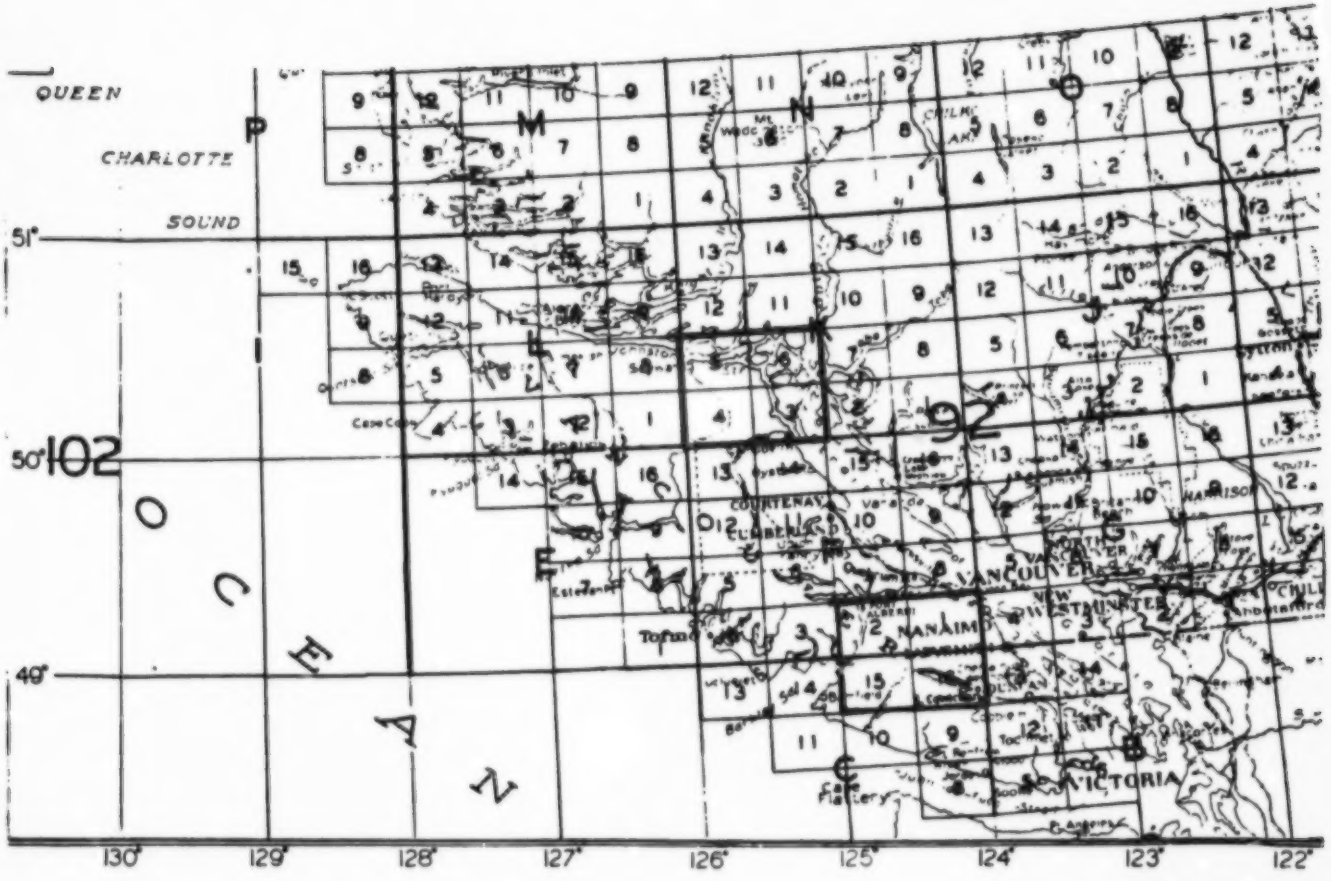

Figure 1. Proposed study areas: Sayward 92K 3, 4, 5, 6; Southcentral Vancouver Island 92F 1, 2 and 92C 15, 16.

Both options meet the objectives of the study. Option two will give a better indication of the successfulness of and the problems encountered in the methodology and the classification system developed. Duplication of the study in two different areas - biogeoclimatically and latitudinally - would enable an assessment of how suitable application of the classification system and corresponding methodologies would be to other areas of Vancouver Island.

A study of the southcentral Vancouver Island area only was not considered an option because this area is currently not a high priority wildlife research area.

3.3.2 Classification

Since it is the purpose of this study to evaluate the classification methodologies of Landsat image analysis, only a simplified version of the process is known at this time. However, in order to provide an understanding of what is entailed, a brief description of each method is presented (Lee, Tomlins, Watson, pers. comm.). An indepth description of the method is to be provided by the individual (hereafter referred to as classification analyst) responsible for their classification analysis.

3.3.2.1 Paper Prints

Although a Landsat paper print at a scale of 1:250 000 represents a whole Landsat scene, the 2 X 2 NTS quadrant matrix which represents the study area will be the only portion of the scene classified. Initial delineation of the area will ensure confinement within the study area.

Identification and delineation of wildlife habitat types will begin with the most obvious colour-tonal differences. Further delineations will be made on areas with less predominant tonal differences with the aid of the aerial photograhs and if need be a magnifying glass. Classification of the delineated habitat types will be made using the information available from the aerial photographs.

This analysis is to be performed by an individual with experience in aerial photograph interpretation. Familiarity with infrared photo interpretation would be advantageous.

3.3.2.2 Positive Transparencies

Positive transparencies are used in conjunction with a Landsat image analysis instrument known as the Colour Additive Viewer (CAV). This format also represents a full Landsat scene. The study area represented by the 2 X 2 quadrant matrix will be cut from the positive transparency.

This section of the positive transparency is placed into the CAV to project an image of the area. Contrast between different features is accomplished by projecting different colours (via filters) through the transparency. Tonal contrasts are recognized as different habitat types. Habitat types are then delineated. Aerial photographs provide the basis for habitat type identification and classification.

3.3.2.3 Computer Tapes (DICS)

Geometrically corrected digital image data (known as DICS) will be used. One DICS tape represents the area of a 2 X 2 NTS quadrant matrix and consequently the area of each study area.

First, homogenous areas which represent the wildlife habitat types are identified on the aerial photographs. These sites provide the training sites necessary for the digital analysis. Consultation between the image analyst and individuals familiar with the area who can identify the habitat types is required. Accurate habitat type identification is important to the success of classification.

During the digital analysis, these training sites are used to develop the spectral signatures of the habitat types. Subsequently all other areas that lie within the specified spectral range of the habitat type are identified as the habitat type. Modifications to the spectral signatures are made to increase the accuracy. Upon refinement of the spectral signatures, the

resultant classification system is run against the entire area. In this manner, all pixels and hence all areas are classified.

Specific analytical techniques used to develop a classification system are presented in the problem analysis (Sadoway 1980).

3.3.3 Area Determination

For each of the habitat types represented an area summary will be calculated.

Area calculations of the wildlife habitat classification systems developed using paper prints and positive transparencies (CAV) will be made using a planimeter or dot-counter. A planimeter is advised because it is more accurate.

The areas of the wildlife habitat classification system developed using the DICS digital data is provided by the computer software.

The area will be reported in hectares, by class.

3.3.4 Evaluation of the Classification Systems

An evaluation will be made on the methodologies and their developed classification systems. The comparative evaluation will be the responsibility of an individual (hereafter referred to as the comparison analyst) who did not perform one of the initial classification analyses. This is designed to minimize bias.

3.3.4.1 Methodology

A description of each of the methodologies used to develop the classification systems will be documented by each classification analyst.

The strengths and weaknesses of the technique will be presented and will be subjective and/or quantitative depending on the method. Specific questions or topics to be addressed are given in Section 4.

The comparison analyst will perform a comparative analysis after completion and submission of all Landsat image analysis reports (total 3).

This evaluation will be made in terms of (1) cost - time and materials; (2) accessibility of manpower and equipment; and (3) accuracy and precision of methodology.

3.3.4.2 Results

Each classification analyst will describe the predicted accuracy and precision of the developed classification. This description will be as quantitative as the methodology permits.

A comparative evaluation of the accuracy of the classification systems will be made by the comparison analyst. This will involve ground truthing via a field survey and it is therefore important that the comparison analyst have ecological classification experience.

The proposed field survey to determine the accuracy of the habitat types and their boundaries involves taking fifty samples in each study area. Sample points will be selected using a sample grid or other unbiased method which can identify conflicting boundaries or types.

A subjective evaluation will be made by those persons who will potentially be utilizing the classification system, in this case, those involved in the elk project in the Sayward Forest (EP 912), the black-tailed deer study (EP 923) and in the MOF Vancouver Region ecosystem study. Other interested parties may also be contacted.

4 PLANNED ANALYSES

4.1 Cost

An initial cost comparison will be made between the three classification methodologies in terms of time and material. Subsequently, an analysis will demonstrate the most effective and efficient methodology to meet research needs.

4.2 Scale

A comparative evaluation will be made of the differences in scale of the products and their usefulness.

4.3 Accuracy

Accuracy is defined as how exact or correct the determined value is.

Each classification analyst will describe the predicted accuracy of the developed classification system regarding location of boundary lines and classification fidelity and homogenity. An evaluation of the predicted accuracy of the area determination will also be made by the classification analyst.

A rank comparison analysis will be used to evaluate the classification accuracy and is the responsibility of the comparison analyst. A subjective rank evaluation of the three classification systems and of their determined areas will also be made by the deer and elk project biologists and other qualified personnel.

4.4 Precision

Precision is defined as the repeatability of a value determined for each sample.

Each classification analyst will describe the predicted precision of the methodology and developed classification system.

4.5 Utility of the Classification System

It is important that the resultant classification systems be evaluated for their usefulness. The classification systems developed will be reviewed by the deer and elk project biologists, other wildlife researchers, and some interested forestry personnel for their subjective evaluation of the current or potential usefulness of the classification system.

4.6 Further Interpretation

Comments will be requested from the classification analysts on further interpretation or application potentials of the system to meet additional objectives (eg. comparison of temporal data).

4.7 Study Area Comparison

If option two is chosen, the suitability of the methodology to classify different areas can be analysed. If one method gives the best results in both study areas, it is assumed that this method will also give the best results in other areas. If, however, the methods do not rank the same in the two areas their suitability in other areas is not clear. This may indicate that different methods may be more suitable to different areas. One or more variables may be identified as the key determinants of method suitability.

5 MEASURES AND RECORDS

Information used to order Landsat images and aerial photograps will be recorded. Record sheets are included in the Appendix (Sec. 11.1.3 and 11.1.4).

Landsat wildlife habitat classification maps developed using paper prints and positive transparencies will be drafted on mylar or acetate sheets. The classification key will be noted on the sheet. This will be the free-hand classification map developed by the classification analyst. A refined classification map can be drafted if requested but this will require additional time. The classification system developed using digital data (DICS) will be recorded on a computer tape and in paper print format.

The area of each wildlife habitat type calculated using paper prints and positive transparencies will be recorded by each classification analyst in a format of their choice. Classified wildlife habitat areas from the digital analysis (DICS) will be on computer tape and in computer printout format. The area calibration will be in hectares.

Each classification analyst will also prepare a report in which the methodology and classification results will be described and discussed. Specific topics to be addressed are presented in Section 4.

The method and results of the comparative evaluation will be preserted in a written report. Topics to be addressed are presented in Sections 3 and 4.

6 MATERIALS AND LABOUR

A complete listing of materials and labour required for Option 1 and 2 are included in the Appendix (Sec. 11.2).

7 COSTS

Option 1 - Sayward Forest

	(a)*	(b)*
Materials	1574	1574
Labour	9065	13 170
Travel Expenses	2825	2145
Rentals	925	825
SUBTOTAL	14 389	17 714
CONTINGENCY 10%	1431	1771
TOTAL	15 820	19 485

Option 2 - Sayward Forest and southcentral Vancouver Island

	(a)*	(b)*
Materials	3128	3128
Labour	15 825	24 025
Travel Expenses	4525	3860
Rentals	1850	1650
SUBTOTAL	28 328	32 663
CONTINGENCY 10%	2832	3267
TOTAL	31 160	35 930

*Note: Column (a), cost when digital analysis done by PFRC
Column (b), cost when digital analysis done by B.C. Research
A complete listing of costs is presented in the Appendix (Sec. 11.3).

8 COMMUNICATION OF RESULTS

Initially the results of each classification analysis will be reviewed and evaluated by the comparison analyst, the deer and elk project biologists, and other appropriate personnel. On completion of the comparative evaluation the comparison analyst will give an oral presentation to the Integrated Wildlife Intensive Forestry Research - Technical Working Group. A written report including the individual classification analyses and the comparative analysis will also be submitted.

9 RESPONSIBILITY

Project organization and supervision will be the responsibility of Karen Sadoway, Research Branch, Ministry of Forests. Classification using the paper

print methodology and field classification evaluation will be carried out by research assistants. Image analysis using positive transparencies (CAV method) will be contracted to Kent Watson, International Range Remote Sensing Ltd., Kamloops. Digital analysis using DICS tapes will be contracted to Geoff Tomlins, B.C. Research, Vancouver or to Jim Lee, Pacific Forest Research Centre, Victoria.

10 LITERATURE CITED

Sadoway, K.L. 1980. Landsat classification system for wildlife management and research planning: problem analysis. Research Branch, Ministries of Environment and Forests, IWIFR-6, Victoria, B.C. 36 p.

11 APPENDIX

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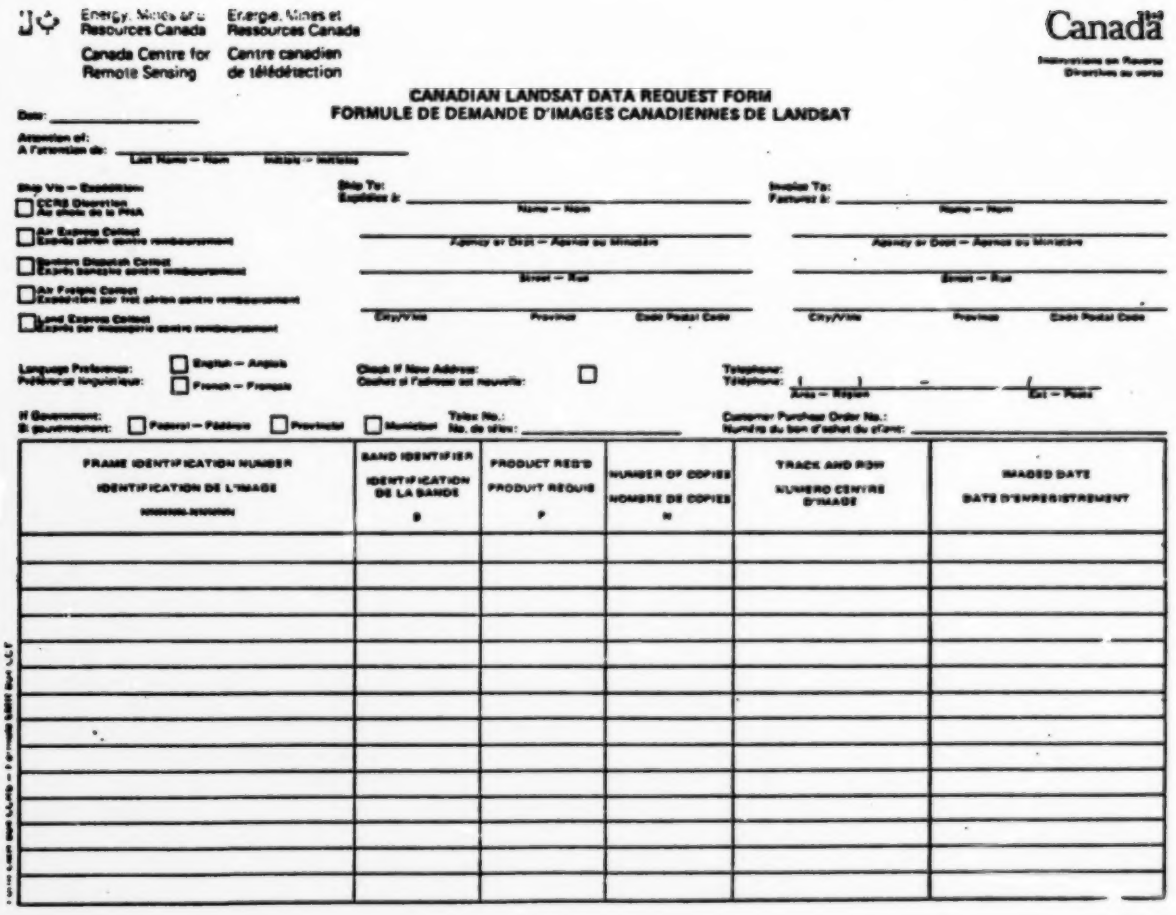
11.1 Material Specifications, Canadian Landsat Data Request Form and Records

11.1.1 Landsat Image and Aerial Photograph Specifications

FORMAT	LANDSAT IMAGES			
	PAPER PRINT	POSITIVE TRANSPARENCY	COMPUTER TAPE	AERIAL PHOTOS
TYPE	Colour 1	Black and White	DICS	B/W; colour
SIZE	792 mm (29.2")	185 mm (7.3")	2X2 NTS (letter, #) quadrant matrix	N/A
SCALE	1:125,000	1:1,000,000	N/A	1:20,000 and/or 1:40,000
NUMBER				
Option 1	1	1	1	N/A
Option 2	2	2	2	
COST[a]	$88/print	$11/transparency	$110/tape	B/W - $2/print Colour - $4.50/print
TURNAROUND TIME	2 weeks	2 weeks	8 weeks	2 weeks
OUTLET	Prince Albert Satellite Station Prince Albert, Saskatchewan		Canada Centre for Remote Sensing, 2464 Sheffield Road Ottawa, Ont.	Survey and Mapping Branch, Min of Environment, Victoria,

[a]Price increase for Landsat images scheduled for June 1, 1981

11.1.2 Canadian Landsat Data Request Form[a]



Energy, Mines and Resources Canada
Canada Centre for Remote Sensing

Énergie, Mines et Ressources Canada
Centre canadien de télédétection

Canada

Instructions on Reverse
Directives au verso

CANADIAN LANDSAT DATA REQUEST FORM
FORMULE DE DEMANDE D'IMAGES CANADIENNES DE LANDSAT

Date: _____

Attention of:
A l'attention de: _____
Last Name — Nom Initials — Initiales

Ship Via — Expédition:
☐ CCRS Objective
Au choix de la PMA
☐ Air Express Collect
Expédié aérien contre remboursement
☐ Surface Dispatch Collect
Expédié terrestre contre remboursement
☐ Air Freight Collect
Expédition par fret aérien contre remboursement
☐ Land Express Collect
Expédié par messagerie contre remboursement

Ship To:
Expédiez à: _____
Name — Nom
_____
Agency or Dept. — Agence ou ministère
_____
Street — Rue
_____
City/Ville Province Code Postal Code

Invoice To:
Facturez à: _____
Name — Nom
_____
Agency or Dept. — Agence ou ministère
_____
Street — Rue
_____
City/Ville Province Code Postal Code

Language Preference:
Préférence linguistique:
☐ English — Anglais
☐ French — Français

Check if New Address:
Cochez si l'adresse est nouvelle: ☐

Telephone:
Téléphone: ( ) _____ - _____ / _____
Area — Région Ext — Poste

If Government:
Si gouvernement: ☐ Federal — Fédéral ☐ Provincial ☐ Municipal

Telex No.:
No. de télex: _____

Customer Purchase Order No.:
Numéro du bon d'achat du client: _____

FRAME IDENTIFICATION NUMBER IDENTIFICATION DE L'IMAGE	BAND IDENTIFIER IDENTIFICATION DE LA BANDE B	PRODUCT REQ'D PRODUIT REQUIS P	NUMBER OF COPIES NOMBRE DE COPIES N	TRACK AND ROW NUMERO CENTRE D'IMAGE	IMAGED DATE DATE D'ENREGISTREMENT

[a] 33% reduction of original

11.1.3 Landsat Image Record

Image Data

Date:
Flight Path and Centre:
Image ID number:
Study area:
Percent cloud cover: scene
study area
Snow Cover: study area

Image Reproduction Data

Format	Type	Size	Scale	Date Ordered	Date Received

11.1.4 Aerial Photograph Record

STUDY AREA:

FLIGHT DATE	FLIGHT #	PHOTO TYPE	SOURCE	SCALE AVAILABLE	SCALE REQUESTED	DATE ORDERED	DATE RECEIVED

11.2 Materials and Labour

11.2.1 Materials

Option 1 - Sayward Forest

Landsat images
- 4 185 mm B/W positive transparencies
- 1 792 mm Colour 1 paper print
- 1 DICS computer tape

Aerial Photographs of area
4 NTS Topographic maps 1:50 000
mylar

Option 2 - Sayward Forest and Southcentral Vancouver Island

Landsat images
- 8 185 mm B/W positive transparencies
- 2 792 mm Colour 1 paper print
- 2 DICS computer tape

Aerial Photographs of area
8 NTS Topographic maps 1:50 000
mylar

11.2.2 Labour

Option 1 - Sayward Forest

Selection and acquisition of material	4 man days
Analysis	
paper print	6 man days
positive transparency	5 man days
DICS - PFRC	8 man days
- B.C. Research	
comparative evaluation	1 man month
Report writing	
paper print	12 man days
positive transparency	2 man days
DICS - PFRC	6 man days
- B.C. Research	
comparative evaluation	2 man months

Option 2 - Sayward Forest and Southcentral Vancouver Island

Selection and acquisition of material	6 man days
Analysis	
paper print	12 man days
positive transparency	10 man days
DICS - PFRC	14 man days
- B.C. Research	7 man days
comparative evaluation	2 man months
Report writing	
paper print	20 man days
positive transparency	4 man days
DICS - PFRC	10 man days
- B.C. Research	14 man days
comparative evaluation	3 man months

11.3 Costs

11.3.1 Cost by Method

Method: Visual Analysis using Paper Print
Analyst: Research Officer 1

Option 1 - Sayward Forest

Analysis	6 days at $75/day	$ 425
Report Writing	12 days at $75/day	$ 900
TOTAL		$ 1325

Option 2 - Sayward Forest and Southcentral Vancouver Island

Analysis	12 days at $75/day	$ 850
Report Writing	20 days at $75/day	$ 1500
	TOTAL	$ 2350

Method: Visual Analysis using Positive Transparencies and a Colour Additive Viewer
Analyst: Kent Watson, International Range Remote Sensing Ltd.

Option 1 - Sayward Forest

Analysis	5 days at $250/day	$ 1250
Report Writing	2 days	$ 500
Travel Expenses	Car - 1000 miles at 29¢/mile	$ 290
Room and Board	Room 3 nights at $50/night	$ 150
	Board	$ 125
SUBTOTAL		$ 2315
CONTINGENCY 10%		230
	TOTAL	$ 2545

Option 2 - Sayward Forest and Southcentral Vancouver Island

Analysis	10 days at $250/day	$ 2500
Report Writing	4 days	$ 1000
Travel Expenses	Car - 1000 miles at 29¢/mile	$ 290
Room and Board	Room 5 nights at $50/night	$ 250
	Board	$ 200
SUBTOTAL		$ 4240
CONTINGENCY 10%		425
	TOTAL	$ 4665

Method: Digital Analysis using DICS tape
Analyst: Jim Lee, Pacific Forest Research Centre, Victoria

Option 1: Sayward Forest

Analysis	8 days	contributed
Report Writing	6 days	contributed
Materials	Film	$ 20
	Product Reproductions	$ 200
Travel Expenses	Flight, Roundtrip to Ottawa	$ 700
	Room and Board	$ 110
Rentals	Car	$ 100
	TOTAL	$ 1130

Option 2: Sayward Forest and Southcentral Vancouver Island

Analysis	14 days	contributed
Report Writing	10 days	contributed
Materials	Film	$ 40
	Product Reproductions	$ 400
Travel Expenses	Flight, Roundtrip to Ottawa	$ 700
	Room and Board	$ 155
Rentals	Car	$ 200
	TOTAL	$ 1495

Method: Digital Analysis using DICS tape
Analyst: Geoff Tomlins, B.C. Research, Vancouver

Option 1: Sayward Forest

Analysis	
Training Site Determination	
1 day at $400/day	$ 400
Classification	
labour, 2 days at 400/day	$ 800
computer time	
10 hrs. at $90/hr. MDA, Van.	$ 900
Accuracy Evaluation	
3 days at $400/day	$ 1200
Report Writing	
1 day at $400/day	$ 400
Materials	
Film	$ 20
Paper Prints	$ 200
Travel Expenses	
Flight, Roundtrip, Van. to Vic.	$ 100
Room and Board	$ 30
SUBTOTAL	$ 4050
CONTINGENCY 10%	$ 405
TOTAL	$ 4455

Option 2: Sayward Forest and Southcentral Vancouver Island

Analysis	
Training Site Determination	
2 days at $400/day	$ 800
Classification	
labour, 4 days at 400/day	$ 1600
computer time	
20 hrs. at $90/hr. MDA, Van.	$ 1800
Accuracy Evaluation	
6 days at $400/day	$ 2400
Report Writing	
2 days at $400/day	$ 800
Materials	
Film	$ 40
Paper Prints	$ 400
Travel Expenses	
Flight, Roundtrip, Van. to Vic.	$ 100
Room and Board	$ 120
SUBTOTAL	$ 8060
CONTINGENCY 10%	$ 800
TOTAL	$ 8860

COMPARATIVE EVALUATION
Analyst: Research Officer 2

Option 1: Sayward Forest

Labour		
Evaluation	1 man month	$ 1820
Report writing	2 man months	$ 3640
Materials		$ 100
Travel Expenses		$ 1450
Rentals		
Truck at $550/month		$ 825
	TOTAL	$ 7835

Option 1: Sayward Forest and Southcentral Vancouver Island

Labour		
Evaluation	2 man months	$ 3640
Report writing	3 man months	$ 5460
Materials		$ 150
Travel Expenses		$ 2900
Rentals		
Truck at $550/month		$ 1650
	TOTAL	$ 13800

11.3.2 Cost: All Methods

Option 1: Sayward Forest

Selection and Acquisition of Images and aerial photographs - 4 man days	$ 300
Materials	
Landsat Images	
Paper Print	$ 88
Positive Transparencies	$ 44
DICS Tape	$ 110
Aerial Photographs	$ 1000
Maps	
NTS Topographic 1:50 000	$ 12
Analysis	
Visual methods	
Paper Print	$ 1325
Positive Transparency/Colour Additive Viewer	$ 2545
*Digital method	
(a) DICS Tape - Pacific Forest Research Centre Cooperative Study	$ 1130
(b) DICS Tape - B.C. Research	$ 4455
Comparative Evaluation	$ 7835

SUBTOTAL	*(a) 14 389	(b) 17 714
CONTINGENCY 10%	1431	1771
TOTAL	15 820	19 485

* cost figures (a) and (b) are total costs including analysis by PFRC and B.C. Research, respectively.

Option 2: Sayward Forest and Southcentral Vancouver Island

Selection and Acquisition of Images and aerial photographs - 6 man days	$ 450
Materials	
Landsat Images	
Paper Print	$ 176
Positive Transparencies	$ 88
DICS Tape $ 220	
Aerial Photographs	$ 2000
Maps	
NTS Topographic 1:50,000	$ 24
Analysis	
Visual methods	
Paper Print	$ 2350
Positive Transparency/Colour Additive Viewer	$ 4665
*Digital method	
(a) DICS Tape - Pacific Forest Research Centre Cooperative Study	$ 1495
(b) DICS Tape - B.C. Research	$ 8860
Comparative Evaluation	$13 800

SUBTOTAL	*(a) 28 328	(b) 32 663
CONTINGENCY 10%	2832	3267
TOTAL	31 160	35 930

* cost figures (a) and (b) are total costs including analysis by PFRC and B.C. Research, respectively.

11.4 Personnel Contacted

Ellis, Rick. Program Manager, Wildlife Habitat Research, Research Branch, Ministry of Forests, Victoria.

Lee, Jim. Researcher, Pacific Forest Research Centre, Victoria.

Redmond, Mary. Terrestrial Studies Branch, Ministry of Environment, Victoria.

Tomlins, Geoff. B.C. Research, Vancouver.

Watson, Kent. International Range Remote Sensing Ltd, Kamloops.